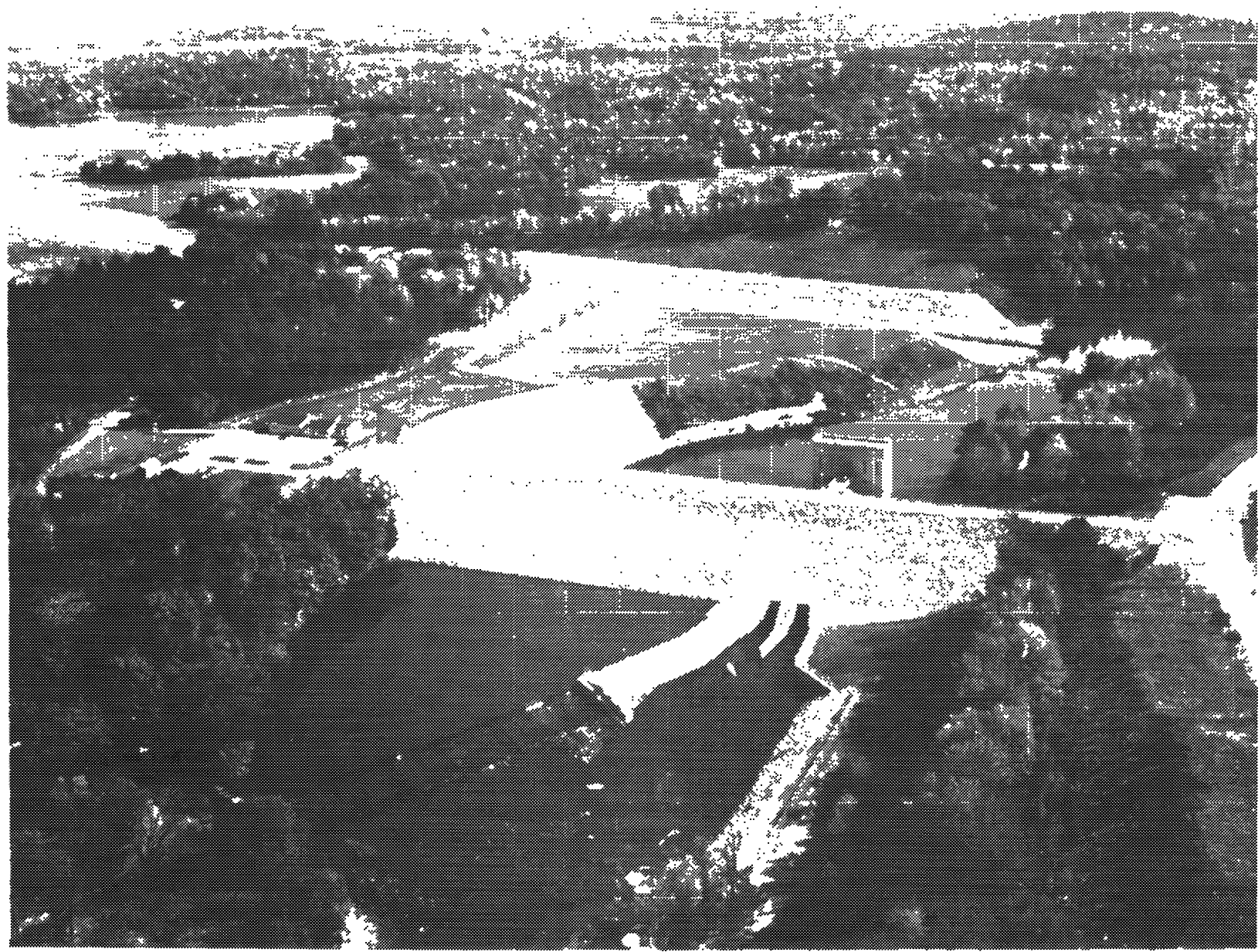
US Army Corps
of Engineers
New England Division

Drought Contingency Plan

JULY 1984

Hopkinton Lake, Hopkinton, New Hampshire



MERRIMACK RIVER BASIN
CONTOOCOOK RIVER WATERSHED

DROUGHT CONTINGENCY PLAN
HOPKINTON LAKE
HOPKINTON, NEW HAMPSHIRE

JULY 1984

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

SYLLABUS

A drought contingency plan was studied for Hopkinton Lake in an effort to be responsive to public needs during drought situations. It was determined that water could be temporarily stored to an elevation of 383 feet NGVD, 3 feet above the permanent pool, providing up to approximately 1,790 acre-feet (580 million gallons) of reservoir storage for drought emergency purposes.

Following an evaluation of impacts on other project purposes resulting from the temporary change in the reservoir storage, it was determined that Hopkinton Lake would not be a good location for the storage of water for public water supply purposes. Poor water quality and upstream industrial and municipal discharges further reduce the water's suitability for public water supply. Also, flowage easements on Contoocook River water at Hopkinton Lake seriously restricts the storage of water for drought purposes.

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HOPKINTON LAKE

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1. PURPOSE AND SCOPE

The purpose of this study and report was to develop and set forth a drought contingency plan of operation for Hopkinton Lake that would be responsive to public needs during drought periods and to identify possible constraints. This evaluation was based on preliminary studies using readily available information. This drought contingency plan includes a description of existing water supply systems, the possibility of reallocation of reservoir storage within specified limits, evaluation of water quality, discussion of impacts on other project purposes, effects on the environment, summary and conclusions.

2. AUTHORIZATION

The authority for the preparation of drought contingency plans is contained in ER 1110-2-1941 which provides that water control managers will continually review and, when appropriate, adjust water control plans in response to changing public needs. Drought contingency plans will be developed on a regional, basinwide and project basis as an integral part of water control management activities.

3. PROJECT AUTHORIZATION CONDITIONS

Hopkinton Lake is a unit of the dual Hopkinton-Everett Lake Project. The combined project was authorized by the Flood Control Act of June 1938, House Document No. 689, 75th Congress, 3rd Session, as amended by the Acts of 1941 and 1944 and the Merrimack River Flood Compact of 1957.

4. PROJECT DESCRIPTION

Hopkinton Lake is located on the Contoocook River about one-fourth mile above the village of West Hopkinton, and 500 feet upstream of the EHC Hydro Associates dam (formerly Sprague Corporation). A map of the Merrimack River basin is shown on plate 1.

The project contains storage for flood control and recreation. The permanent pool at elevation 380 feet NGVD is maintained by flashboards at the EHC Hydro Associates dam located immediately downstream of Hopkinton Dam. This permanent pool is maintained at a depth of about 14 feet creating a 220-acre pool and contains 700 acre-feet of storage. The flood control storage amounts to 70,100 acre-feet (22.8 billion gallons) when filled to spillway crest. A capacity table is shown on plate 2 and a summary of pertinent data at Hopkinton Lake is contained on plate 3.

Components of the project consist of a rolled earthfilled dam with rock slope protection, a concrete spillway, outlet works, a canal and two earth dikes. The outlet works consists of an intake structure and gate tower and three 11-foot square conduits, each containing two 6-foot wide by 12-foot high gates with inverts at elevation 366. Two conduits discharge into two 32 by 67-foot stilling basins and the Contoocook River. The third discharges directly into the forebay pool, which is controlled by the EHC Hydro Associates dam.

Dike H-2, with a length of 5,200 feet, is located on Elm Brook above its junction with the Contoocook River. Dike H-3, with a length of 4,400 feet, is located between the Elm Brook Pool and the Contoocook River valley.

Canal No. 1 has a total length of 4,000 feet and connects the Contoocook and Elm Brook pools. Recreation and swimming are components of the Elm Brook Pool. The invert of the main channel is at elevation 382, with a pilot channel at invert elevation 376.

5. PRESENT OPERATING REGULATIONS

a. Normal Periods. A permanent pool is maintained at about elevation 380 by flashboards at the Hoague-Sprague Corporation dam to provide the head and pondage necessary for boxboard production and fire protection at that company. The gate settings, 0-0-0-0-6'-6', restricts discharges so that significant reservoir releases will not occur during unexpected events.

b. Flood Periods. The Hopkinton project is operated in concert with other projects in the basin to reduce downstream flooding along the Contoocook River and further downstream in the Merrimack River. Operations for floods may be considered in three phases: phase I - appraisal of storm and river conditions during development of a flood; phase II - flow regulation and storage of flood runoff at the reservoir, and phase III - emptying the reservoir during recession of the flood. The regulation procedures are detailed in the Master Water Control Manual for the Merrimack River Basin.

c. Regulating Constraints

(1) Minimum Releases. A minimum release of about 50 cfs (32 mgd) is maintained during periods of flood regulation for fire-fighting and to sustain downstream fish life.

(2) Maximum Releases. The maximum nondamaging discharge capacity of the channel immediately downstream of Hopkinton Lake is about 7,000 cfs. Releases at or near this rate can be expected whenever reservoir inflows exceed this value, and meteorologic and hydrologic conditions permit.

6. MONITORING OF HYDROLOGIC CONDITIONS

The Reservoir Control Center directs the reservoir regulation activities at 28 New England Division flood control dams, and continually monitors rainfall, snowcover and runoff conditions throughout the region. When any of these hydrologic parameters have been well below normal for several months and it appears that possible drought conditions might develop, the Corps Emergency Operations Center (EOC) will be so informed. The EOC will then initiate discussions with the respective Federal and State agencies and other in-house Corps elements to review possible drought concerns and future Corps actions.

7. DESCRIPTION OF EXISTING WATER SUPPLY CONDITIONS

a. General. The area of concern is the central portion of New Hampshire including portions of Hillsborough and Merrimack counties. Table 1 contains information about public water suppliers in the area based on information provided by the New Hampshire Water Supply and Pollution Control Commission. Of the 17 communities in the study area, 12 are served by public systems. No data is available for those communities dependent on private individual supplies.

b. Water Supply Systems. The primary objective of this analysis was to accumulate available data regarding water supply systems in the vicinity of Hopkinton Lake that could benefit from storage at the project, and to present the data in a manner portraying existing water supply conditions. Projections of future demands were not developed because this study addresses only modification in the operational procedure at Hopkinton Lake in order to provide storage for water supply purposes when drought conditions exist, and not to meet normal water supply demands at some future date.

c. Central New Hampshire Water Suppliers. As noted in table 1, the data given for each water supplier includes: community served, estimated population served by the system, source of supply (ground or surface water), average day and maximum day demands for 1981, estimated safe yield of the source, and any further information available on the source of supply. An analysis of the adequacy of existing sources during drought conditions has not been performed. The information has

TABLE 1
MAJOR WATER SUPPLIERS - CENTRAL NEW HAMPSHIRE

Company or Agency	Town Served	Est. Population Served 1981	Source of Supply SW/GW	1981 Demand Avg. Day (MGD)	1981 Demand Max. Day (MGD)	Supply Source	Safe Yield (MGD)
	Bedford	(656 Connections)				Manchester Water Works	
Boscawen/ Penacook Water Precinct	Boscawen	800	SW	0.485	0.800	Walker Pond	2.20
	Bow	(1 Connection)				Concord Water Works	
	Bradford		No Public Water Supply				
Concord Water Works	Concord	(7.198 Connections)	SW/GW	4.043	6.150	Long Pond	2.60
						Contooocook R.(Ave)	10.00
						GP #1 Tr. Pland	1.00
						GP #3	1.00
						GP #5	1.00
						GP #7	1.00
	Deering	(9 Connections)				Hillsborough Water Works	
	Dunbarton		No Public Water Supply				
Goffstown Village Water Precinct	Goffstown	3100	GW	0.175	0.350	Dug	0.13
						BR #1	0.16
						Dugwell	0.05
						BR #2	0.02
		(931 Connections)				(Manchester Water Works)	
Cogswell Spring Water Works	Henniker		GW	0.350	0.450	GP #1	-
						GP #2	-
						GP #3	-
Hillsboro Water Works	Hillsboro	2000	SW	0.300	0.450	Loon Lake	1.20

Company or Agency	Town Served	Est. Population Served 1981	Source of Supply SW/GW	1981 Demand Avg. Day (MGD)	1981 Demand Max. Day (MGD)	Supply Source	Safe Yield (MGD)
Hillsboro Water Co. Inc. (Emerald Lake Shores)		(275 Connections)	GW			BR #1 BR #4 BR #5 BR #6	0.04 0.04 0.03 0.02
Hooksett Village Water Precinct	Hooksett	2400	SW	0.150	-	Pinnacle Pond	--
Central Hooksett Water Precinct		1500	GW	0.275	0.475	GP #1 GP #2 GP #3	0.20 0.21 0.20
		(299 Connections)				Manchester Water Works	
Contoocook Fire District	Hopkinton	1500	SW	0.225	0.320	Bear Pond	0.48
Manchester Water Works	Manchester	105,000	SW	13.000	26.000	Lake Massabesic	22.00
	New Boston		No Public Water Supply				
Warner Village Fire District	Warner	525	SW/GW	0.045	0.063	Silver Lake BRW #1 (Aux)	-- --
Weare			No Public Water Supply				
Webster			No Public Water Supply				

been accumulated to present a summary of the existing water supply conditions for the central New Hampshire area.

d. Population Projections. Population projections for communities in central New Hampshire are given in table 2 to show population trends for each community potentially affected by a prolonged dry period. The projections were provided by the New Hampshire Office of State Planning based on criteria derived by the Corps of Engineers for the Southeastern New Hampshire Water Resources Study.

8. POTENTIAL FOR WATER SUPPLY REALLOCATION

a. General. There are several authorities that provide for the use of reservoir storage for water supply at Corps of Engineers projects. They vary from the provision of water supply storage as a major purpose in new projects to the discretionary authority to provide emergency supplies to local communities in need. In addition, guidance contained in ER 1110-2-1941 directs field offices to determine the short-term water supply capability of existing Corps reservoirs. Congressional authorization is not required to add municipal and industrial water supply if the related revisions in regulation would not significantly affect operation of the project for the originally authorized purposes.

b. Drought Contingency Storage. It has been determined that a portion of the existing storage at Hopkinton Lake could be utilized for emergency drought storage without having an adverse impact on the project's flood control function. Storage could be made available to a pool elevation of about 383 feet (17 foot stage). This represents a volume of about 1,790 acre-feet, equivalent to 580 million gallons or about two and two and one-half percent of the total Hopkinton reservoir storage. This volume is comprised of 700 acre-feet of permanent storage (elevation 380), and 1,090 acre-feet of flood control storage (elevation 383). The 1,790 acre-feet represents an infringement of about 0.10 inch of runoff on the flood control storage from the total net drainage area of 382 square miles (total drainage area is 426 square miles).

Based on an all-season low flow duration analysis using 18 years of flow records for the gaging station on the Contoocook River at West Hopkinton, New Hampshire, it was determined that during a 10-year frequency drought period, the volume of runoff could: (a) fill the reservoir from elevation 380 to 383 feet in a 12-day period provided no releases were made from the dam, or (b) fill the reservoir to elevation 383 in a 27-day period if a continuous release of about 43 cfs or 28 mgd (0.10 cfs/sq. mi., csm) were maintained. Drought contingency storage versus flow duration at Hopkinton Lake is graphically shown on plate 4.

TABLE 2
POPULATION PROJECTIONS - CENTRAL NEW HAMPSHIRE

TOWN	Actual 1980	1985	1990	1995	2000	Percent-Change 1980-2000
Bedford	9,500	10,944	11,803	12,728	13,289	39.8
Boscawen	3,419	3,470	3,496	3,527	3,586	4.9
Bow	4,014	4,653	5,246	5,915	6,422	60.0
Bradford	1,109	1,285	1,448	1,632	1,772	59.8
Concord	30,360	31,502	32,107	32,774	33,639	10.8
Deering	1,046	1,204	1,299	1,400	1,462	39.8
Dunbarton	1,173	1,360	1,529	1,719	1,863	58.8
Goffstown	11,319	12,694	13,366	14,103	14,720	30.0
Henniker	3,236	3,612	3,915	4,251	4,558	40.9
Hillsborough	3,431	3,747	3,924	4,110	4,222	23.0
Hooksett	7,293	7,978	8,484	9,027	9,364	28.4
Hopkinton	3,841	4,314	4,713	5,149	5,471	42.4
Manchester	90,757	92,671	93,293	93,955	94,612	4.2
New Boston	1,947	2,235	2,411	2,600	2,715	39.4
Warner	1,956	2,268	2,500	2m757	2,948	50.7
Weave	3,218	3,706	3,996	4,310	4,499	39.8
Webster	1,092	1,265	1,424	1,604	1,742	59.5
TOTAL	178,715	188,908	194,954	201,561	206,884	15.8

The Hopkinton Reservoir could be filled to elevation 383 in about a one-week period in May while continuously releasing about 85 cfs or 55 mgd. The stored water could be drawn directly from the reservoir for municipal supply with proper treatment or released downstream during or after the completion of filling.

c. Effects of Regulated Flows. As discussed, the curtailment of flows from Hopkinton Lake during the drought emergency could adversely impact on the flowage rights of downstream riparian users. At this time, however, it is not possible to review all of the various drought emergency situations that could occur, nor is it within the scope of this report to identify all those with water rights. It is important to note that when a specific drought emergency does occur, the legal implications would have to be weighed.

d. Downstream Water Users. EHC Hydro Associated (formerly Hoague-Sprague) is a riparian user of Contoocook River waters just downstream of Hopkinton Lake in West Hopkinton, New Hampshire. The EHC dam, located about 500 feet downstream of the Hopkinton Dam, has a top flashboard elevation of 380 feet NGVD. The existing pond extends up through the Hopkinton Dam and also forms the existing permanent pool upstream of the dam. The owners of EHC have existing flowage easements to elevation 380 within Hopkinton Lake with the capability of withdrawing water up to a rate of 500 cfs for hydropower generation. Therefore, this flowage easement places a serious restriction on the storage of water for drought contingency purposes.

9. WATER QUALITY EVALUATION

a. Water Quality Classification. The water of the Contoocook River as it flows through the Hopkinton Lake project is assigned a class B objective by the New Hampshire Water Supply and Pollution Control Commission. Class B waters have high aesthetic value and are acceptable for swimming and other recreation, fish habitat, and, after adequate treatment, for use as water supplies.

b. Existing Water Quality. Hopkinton Lake has two pools under normal conditions, and the water quality in each is different. Immediately behind the Hopkinton Dam is the Contoocook River impoundment which is normally at elevation 380 feet NGVD. The Contoocook River upstream from that point receives discharges from 12 significant point sources including municipal and industrial wastewaters. The waters of the Contoocook River at Hopkinton Lake are of fair quality and do not fully meet the goals for a class B water. High levels of coliform bacteria and nutrients

from upstream discharges are the principal problems. The waters also have high levels of color, iron and manganese, and low pH levels due to natural conditions in the watershed. Although nutrient levels are high in the Contoocook River, the hydraulic detention time in the impoundment behind Hopkinton Dam is short and the pool does not experience algae bloom problems.

Elm Brook pool is a large shallow recreational impoundment within the Hopkinton Lake project area. It is normally maintained at elevation 383 feet NGVD and discharges into the Contoocook River over a weir. Elm Brook pool has generally good water quality which usually meets the goals for a class B water. Although there is little inflow to the pool and, therefore, little flushing, nutrient levels are low and the pool does not have algae bloom problems. The water is high in color, iron and manganese, and low in pH, but these are due to naturally occurring conditions in the watershed and do not affect the present uses of the water.

Serious water quality programs can occur in Elm Brook pool when the waters of the Contoocook River exceed elevation 383 and flow into the pool. In June and July 1973, a series of storms caused the Contoocook River level to exceed elevation 383 for 9 days. This caused excessive contamination of the water in the swimming area and forced the Elm Brook pool area to remain closed for the entire summer. A number of wastewater treatment plants have been built in the Contoocook watershed since 1973 and the water quality has improved, but high coliform counts still occur and leave open the possibility of future contamination.

c. Water Quality Requirements for Drought Storage. There are two requirements to be met. The waters must meet state standards for surface waters and must be of a quality suitable for the water supply user. A water which meets class B standards could be made usable for public water supply with standard treatment processes. The water quality required for industrial water supply depends on the industrial process involved. The water at Hopkinton Lake would always be of a quality suitable for fire-fighting.

d. Effects of Drought Storage. The principal effect of increasing the size of the Contoocook pool at Hopkinton Lake for drought storage will be to cause the waters of the Contoocook River to mix with those of Elm Brook pool more often. Because the two pools would be at the same level, any increase in stage in the Contoocook River would cause it to flow into Elm Brook pool. This could cause a repeat of the 1973 high coliform counts which forced closure of the recreation area. It could

also cause problems by introducing the high levels of nutrients in the Contoocook River into Elm Brook pool with its long hydraulic detention time. This combination could cause significant algae bloom problems. Algae blooms are unsightly and can cause taste and odor problems in the water. In addition, nighttime algal respiration can deplete oxygen in the water which can be fatal to fish.

The effects of high coliform levels or algae blooms would be felt by recreational users and water supply users of the water. High coliform counts could make the water unsafe for contact recreation and algae blooms could make the water undesirable for swimming. Coliform bacteria can be removed from water, intended for public supply, by standard treatment processes but the taste and odor caused by algae blooms would not be as easy to remove.

The effects of the increased pool size on water quality in the Contoocook River impoundment behind the dam and in the river below the dam would be minimal. Compliance with state stream standards would not be affected.

e. Water Quality Conclusions. High coliform counts, color, iron and managanese levels in the Contoocook River make the water undesirable for use as public water supply, although all these parameters can be removed by standard treatment processes. Twelve upstream industrial and municipal discharges further reduce the water's suitability for public water supply by increasing the possibility of some other contamination being in the water. Therefore, it was determined that Hopkinton Lake would not be a good location for the storage of water for public water supply purposes.

Increasing the pool at Hopkinton Lake for drought storage will mix the waters of the Contoocook River with those of Elm Brook pool more often. This could introduce algae blooms and high coliform counts into Elm Brook pool and seriously interfere with the recreational use of the project. Algae blooms could also add difficult-to-remove taste and odor to the water which would interfere with its use as public water supply. The water would be usable for fire-fighting and some industrial uses.

10. DISCUSSION OF IMPACTS

a. General. Any action resulting in a temporary change of a reservoir's storage volume might have impacts on other project purposes which must be evaluated before a storage reallocation plan can be implemented. An evaluation has been made of the impacts resulting from drought contingency storage on the flood control purpose of this project. Effects on recreation, sedimentation and the aquatic and terrestrial environments,

as well as the historic and archaeological resources are discussed in the following paragraphs. Because of the minimal level of effort afforded this study, certain environmental concerns may require further consideration prior to implementation. These are identified in the appropriate environmental sections, including some with estimates of the amount of time needed for such assessments.

b. Flood Control. A review of the regulation procedures at Hopkinton Lake was undertaken to determine the volume of water that could be made available for drought contingency purposes. The water would be stored by temporarily utilizing existing flood control storage. It is recognized that major floods occur in every season of the year, thus any use of flood control storage would be continually monitored to insure there would be no adverse impacts on downstream flood protection.

At Hopkinton, the maximum pool elevation for drought contingency storage has been estimated to be elevation 383 feet, representing an infringement on the flood control storage of about 0.10 inch of runoff from the total net Hopkinton Reservoir drainage area of 382 square miles.

Based on a 10-year event, the anticipated rate of pool level rise would exceed 0.10 foot per day over a 27-day period beginning in June. This condition assumes a flow of about 43 cfs (28 mgd) would be released downstream for the duration of the drought. Storage would probably take place during the months of June, July and August and would be drawn as needed in subsequent months. It is likely that the storage would be held for a period of one month or longer at the 383-foot elevation before withdrawal.

c. Recreation. Limiting the drought contingency storage to elevation 383 will protect the recreational values of the Elm Brook pool and will spare shoreline and riverbank vegetation.

d. Project Operations. In order to maintain the Hopkinton drought storage pool at elevation 383, it will be necessary to regulate gates. All costs associated with adjusting gates for drought storage, removal of abnormal amounts of floating trash at the log boom, and removal of any vegetation that dies as a result of long term flooding.

e. Effects on the Terrestrial Environment. The habitat surrounding the reservoir is primarily made up of upland forest, open field, and forested wetland vegetative cover types. Roughly 60 percent of the area is wooded. Common upland species are dominated by white pine and eastern hemlock. Wooded swamp areas include such species as red maple, gray birch, red oak and sugar maple. Other species present are quaking aspen, bass wood, black cherry, yellow birch, and paper birch. Pure stands of red alder are also numerous. Forestry management practices maximize forest edge to provide a variety of habitats for the area's wildlife species.

The Hopkinton-Everett Reservoir is considered very good game habitat. Whitetail deer are the only big game animals found in the reservoir area. Moose and bear have been reported in the area, but probably occur as occasional migrants. Grouse, snowshoe hare, woodcock, cottontail rabbits, gray squirrels and pheasants are the primary upland game species found at the project. Selected sites in the project area are stocked with pheasant by the New Hampshire Fish and Game Department every fall. Several species of waterfowl including woodchuck, hooded merganses and black ducks are also common in the wetland areas within the reservoir.

Fur bearing animals found throughout the project area include beaver, raccoon, muskrat, fisher, mink, otter, fox, skunk and weasel. Trapping in the reservoir area is primarily for beaver and muskrat. Raising the reservoir level two feet above the permanent pool would flood muskrat, beaver, otter, and mink den habitats and could cause direct mortality to young and newborn litters of these species.

Those species listed in the Federal Register as "endangered" are eligible for benefits provided by the Endangered Species Conservation Act of 1973. "Threatened" species are also eligible for endangered species benefits. Under the legislation, "special consideration" is given to those species which may not be threatened throughout the entire range in the United States but have declined significantly in a particular area such as New Hampshire.

Those endangered species which may pass through the Hopkinton-Everett dam and reservoir are the bald eagle and the American peregrine. Threatened species which may be present or may pass through are the Southeastern pine grosbeak, Eastern pigeon hawk, American osprey.

Those species of special concern include common loon, barn owl, and Eastern bluebird (Sialis sialis) and New England cottontail. The increase in the pool level would not affect nesting or feeding of any of these bird species. Pheasant stocking and hunting exist on a put-and-take basis. The fish and wildlife resources at this project are considered by sportsmen as among the most significant in southern New Hampshire.

Tree mortality rates are highest when impoundments occur during the growing season. Those which occur in late fall, winter or early spring are generally not harmful to trees if physical damage does not result. As a result of mortality from flooding, the cover type adjacent to the pools where flooding is more frequent would be expected to open and or in some cases convert to more flood-tolerant species than was originally present.

The impact of the increase in pool elevation would be to inundate an additional five acres of shoreline habitat. Because storage in the current and recent years has been above the existing recreational pool, the actual area of inundated upland would be considerably less. The proposed increase would inundate some shoreline vegetation that may be useful to wildlife

or food or nesting habitat. The degree of impact is essentially dependent on the timing of inundations. If storage took place during the nesting season, the nest of fish species such as the large-mouth bass, and its contents may be inundated. However, the conditions subjected to resident species by the proposed storage have previously occurred during normal flood control operations without significant impacts to the resident populations. Plate 5 shows a map of the reservoir area.

The three-foot increase in the pool elevation would not affect the recreational beach and park area. The shoreline is cleared back far enough however, that only a few trees would be adversely impacted and then only if the water level was maintained in excess of a week or ten days time period. The potential effects on a new shoreline would include sloughing, erosion, and root exposure due to prolonged operation. These effects would have to be assessed in more detail. Should the contingency storage be required for prolonged periods, continuous use or for repetitive frequent use, the impacts on the existing wetlands and the potential that new wetlands may be created would have to be assessed, requiring a few days of effort.

f. Effect on the Aquatic Environment. The aquatic environment of the project areas(s) consists of the reservoir and downstream riverine habitats. The reservoir waters provide a good fishery resource. The Contoocook River, Elm Brook pool and marsh, Everett Lake, Drew Lake and Stumfield marsh all have good populations of several species of game fish. Everett Lake has both small and largemouth bass, bullheads, yellow perch, pickerel and brown trout. Large and small mouth bass, bullheads, pickerel, white and yellow perch are the most important species found in the Contoocook River.

Impacts to the reservoir fishery are mainly concerned with the self-sustaining largemouth bass population. This species generally nests in sand or gravel covered shallow areas around the lake perimeter during May and early June. Impacts would be generally related to the extent, frequency and timing of the pool fluctuations.

g. Historic and Archaeological Resources. Examination of mid-19th century maps reveals one recorded historic period site below 383 NGVD, and no prehistoric resources are recorded within the project. However, as the project has never been subjected to an archaeological survey, unrecorded prehistoric or historic resources may exist within the area affected by this drought contingency plan. Prior to drought contingency plan implementation, an archaeological survey would be required involving a few weeks duration.

11. SUMMARY AND CONCLUSIONS

A drought contingency plan was studied for Hopkinton Lake in an effort to be responsive to public needs during drought situations. Water could be temporarily stored to an elevation of 383 feet. At this level, 3 feet above the permanent pool, it would be possible for the project to provide up to approximately 1,740 acre-feet (580 million gallons) of reservoir storage for drought emergency purposes.

It was determined that Hopkinton Lake would not be a good location for the storage of water for public water supply purposes. High coliform counts, color, iron and manganese levels in the Contoocook River make the water undesirable for potable use. Upstream industrial and municipal discharges further reduce the water's suitability for public water supply by increasing the possibility of some other contamination being in the water. Also, flowage easements on Contoocook River water up to elevation 380 feet NGVD at Hopkinton Lake seriously restricts the storage of water for drought purposes.

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LINCOLN LOCAL PROTECTION

FRANKLIN FALLS DAM

BLACKWATER DAM

HOPKINTON-EVERETT LAKES

EDWARD MacDOWELL DAM

NASHUA LOCAL PROTECTION

HAVERHILL LOCAL PROTECTION

FITCHBURG LOCAL PROTECTION

LOWELL LOCAL PROTECTION

SAXONVILLE LOCAL PROTECTION

LOCATION MAP
SCALE IN MILES
0 10 20 30 60

LEGEND
△ STREAM GAGING STATION
♦ CORPS SNOW SURVEY COURSE

SCALE IN MILES
0 4 8 12 16

WATER RESOURCES DEVELOPMENT PROJECT
MERRIMACK RIVER BASIN
BASIN MAP
NEW ENGLAND DIVISION, WALTHAM, MASS.

PLATE 1

AREA-CAPACITY TABLE

HOPKINTON AND EVERETT LAKES

Hopkinton Lake DA = 382 square miles (net) 1 inch Runoff = 20,358 acre-feet (net)			Everett Lake DA = .66 square miles 1 inch Runoff = 3,410 acre-feet					
Pool Elevation (ft, msl)	Area (acres)	Capacity (ac/ft)	Pool Elevation (ft, msl)	Area (acres)	Capacity (ac/ft)	Pool Elevation (ft, msl)	Area (acres)	Capacity (ac/ft)
380*	220	700	340*	115	1,000	380	1,016	18,500
381		1,000	341		1,100	381		19,500
382		1,360	342		1,200	382		20,500
383		1,790	343		1,325	383		21,750
384		2,225	344		1,450	384		23,000
385	610	2,760	345	175	1,675	385	1,288	24,250
386		3,390	346		1,900	386		25,500
387		4,200	347		2,100	387		26,750
388		5,030	348		2,300	388		28,000
389		6,050	349		2,500	389		29,585
390	1,130	7,150	350	243	2,700	390	1,485	31,170
391		8,490	351		2,950	391		32,585
392		9,700	352		3,200	392		34,000
393		11,050	353		3,450	393		35,900
394		12,450	354		3,700	394		37,800
395	1,590	14,000	355	297	4,000	395	1,702	39,400
396		15,790	356		4,300	396		41,000
397		17,550	357		4,650	397		42,750
398		19,360	358		5,000	398		44,500
399		21,385	359		5,345	399		46,500
400	2,110	23,500	360	361	5,690	400	1,942	48,500
401		25,300	361		6,095	401		50,250
402		27,750	362		6,500	402		52,000
403		30,100	363		6,900	403		54,250
404		32,600	364		7,300	404		56,500
405	2,650	35,200	365	444	7,750	405	2,207	58,750
406		38,000	366		8,200	406		61,000
407		40,900	367		8,650	407		63,250
408		43,800	368		9,100	408		65,500
409		46,800	369		9,700	409		67,940
410	3,200	49,840	370	617	10,300	410	2,497	70,380
411		53,125	371		11,000	411		72,990
412		56,400	372		11,700	412		75,600
413		59,800	373		12,350	413		78,300
414		63,400	374		13,000	414		81,000
415	3,600	66,580	375	809	13,875	415	2,829	83,750
416**		70,800	376		14,750	416		86,500
417		74,300	377		15,625	417		89,500
418		78,250	378		16,500	418**		92,500
419		82,295	379		17,500	419		95,500
420***	4,090	86,300				420***	3,140	98,500

* Permanent Pool
** Spillway Crest
*** Flowage Easement Limit

PLATE 2

PERTINENT DATA

HOPKINTON-EVERETT LAKES

	Hopkinton	Everett	Total
LOCATION	Contoocook River, Hopkinton, N. H.	Piscataquog River, Weare, N. H.	
DRAINAGE AREA	382 square miles*	64 square miles	446 square miles*
STORAGE USES	Flood control and recreation		
RESERVOIR STORAGE			
At Inlet Elevation (ft, msl)	366	325	-
Area (acres)	0	0	0
Acre-Feet	0	0	0
At Permanent Pool (ft, msl)	380	340	-
Area (acres)	220	130	350
Acre-Feet	700	1,000	1,700
Inches on Drainage Area	Less than 0.1	0.3	Less than 0.1
At Spillway Crest (ft, msl)	416	418	-
Area (acres)	3,700	2,900	6,600
Acre-Feet	70,100**	91,500**	161,600**
Inches on Drainage Area	3.4	26.8	6.8
EMBANKMENT FEATURES			
Type	Rolled earth fill with rock slope protection		
Length (feet)	790	2,000	
Top Elevation (ft, msl)	437	435	
Maximum Height (feet)	76	115	
Top Width (feet)	24	24	
Slopes	1 on 2.5	1 on 2 to 1 on 2.5	
SPILLWAYS			
Type	Concrete ogee weir	Concrete ogee weir	
Crest Length (feet)	300	175	
Crest Elevation (ft, msl)	416	418	
Location	1.5 miles east of dam	Left abutment	
SDF Surcharge (feet)	14	12	
SDF Discharge (cfs)	59,700 (spillway) 13,200 (conduit)	28,500 (spillway 4,600 (conduit)	
SDF Peak Inflow (cfs)	135,000	68,000	
OUTLET WORKS			
Type and Number	3 square conduits (2 flood control, 1 forebay)	1 circular conduit	
Conduit Inside Dimensions	11 feet x 11 feet	8 feet diameter	
Conduit Lengths (feet)	Flood control 124, forebay 128	350	
Invert Elevation (feet, msl)	366	325	
Service Gates	6 @ 12 feet high x 6 feet wide (4 flood control, 2 forebay)	3 @ 6 feet high x 3.5 feet wide	
Emergency Gates	1 @ 12 feet high x 6 feet wide	None	
Downstream Channel Capacity (cfs)	7,000	1,500	
Maximum Discharge Capacity (spillway crest elevation)	14,000 cfs	2,900 cfs	
Stilling Basins			
Number	2***	1	
Size	32 feet wide x 67 feet long	30 feet maximum width x 50 feet length	

DIKE FEATURES	H-2	H-3	P-1	P-2
Type	Compacted earth fill with rock slope protection			
Length (feet)	5,220	4,400	4,050	2,630
Top Elevation (ft, msl)	435	435	435	435
Maximum Height (feet)	66	67	50	30
Conduits	Dike P-1 only: Inlet elevation 384.6 feet msl Dimensions: Length 220, width 4 feet, height 5 feet			

CANALS	Canal No. 1	Canal No. 2
Designation	120	160
Bottom Width (feet)	4,000	10,400 (from North Weir to South Weir)
Length (feet)	1 on 2.5 to 1 on 3	1 on 2.5
Side Slopes		

LAND ACQUISITION			Total Acres
Fee Taking Elevation (ft, msl)	410	400	7,910 Fee
Flowage Easement Elevation (ft, msl)	420	420	2,024 Easement
Downstream Flowage Easement (cfs)	7,000	1,500	
MAXIMUM POOL OF RECORD			
Date	April 1969	April 1969	
Elevation (ft, msl)	405.0	397.1	
Percent of Flood Control Storage	0	0	47
UNIT RUNOFF			Both Projects
One Inch Runoff (acre-feet)	-	-	23,760 (net)
OPERATING TIME			
Open/Close All Gates	15 minutes	20 minutes	
PROJECT COST (Through FY 1974)	-	-	$21,360,000
DATE OF COMPLETION	October 1962	December 1961	-
MAINTAINED BY	New England Division, Corps of Engineers		

* Net drainage area - does not include 44 square miles controlled by MacDowell Dam

** Net (flood control) above permanent pool

*** For flood control conduits; forebay conduits empties into forebay pool (w.s. elevation = 380 feet)

PLATE 3

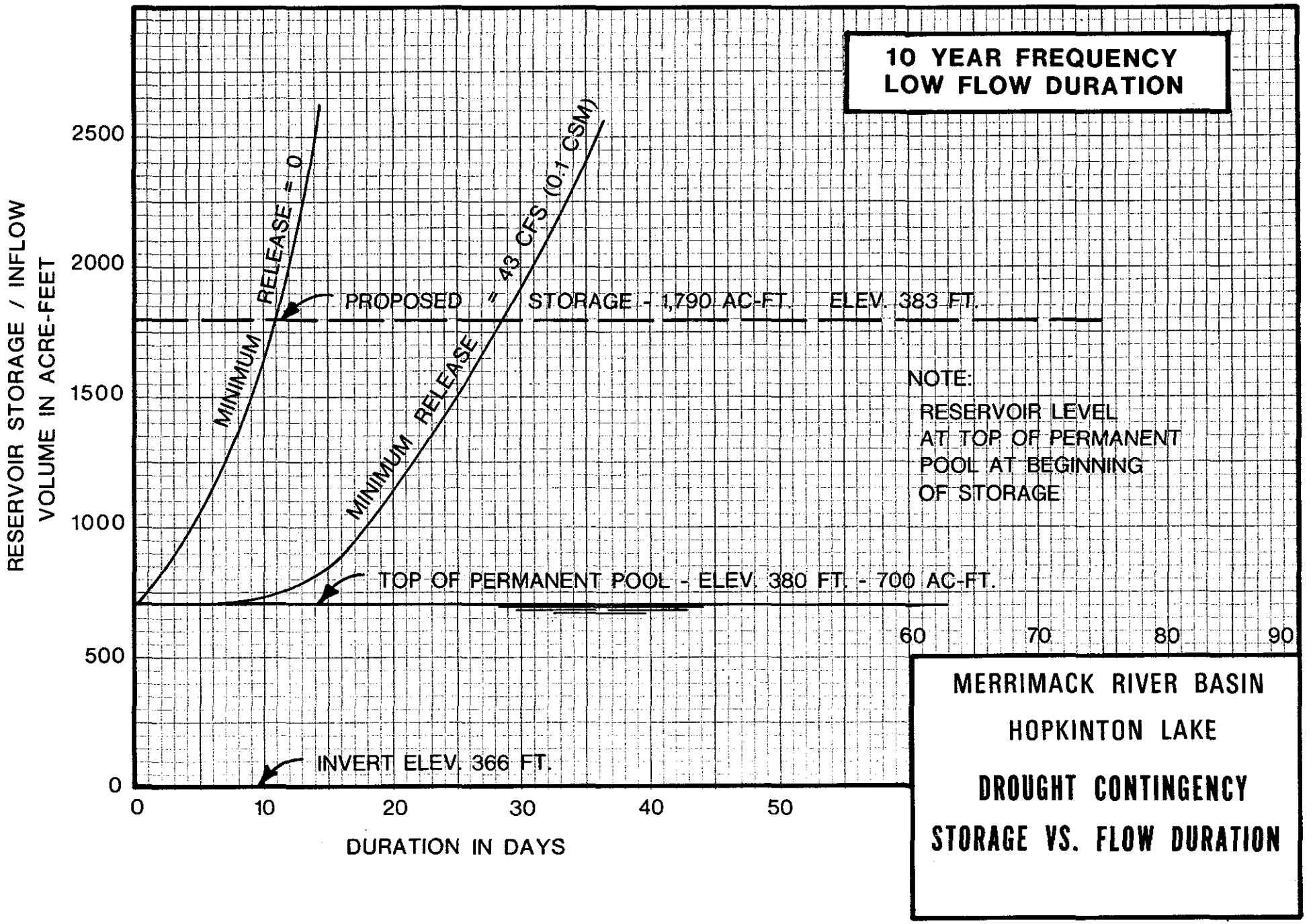
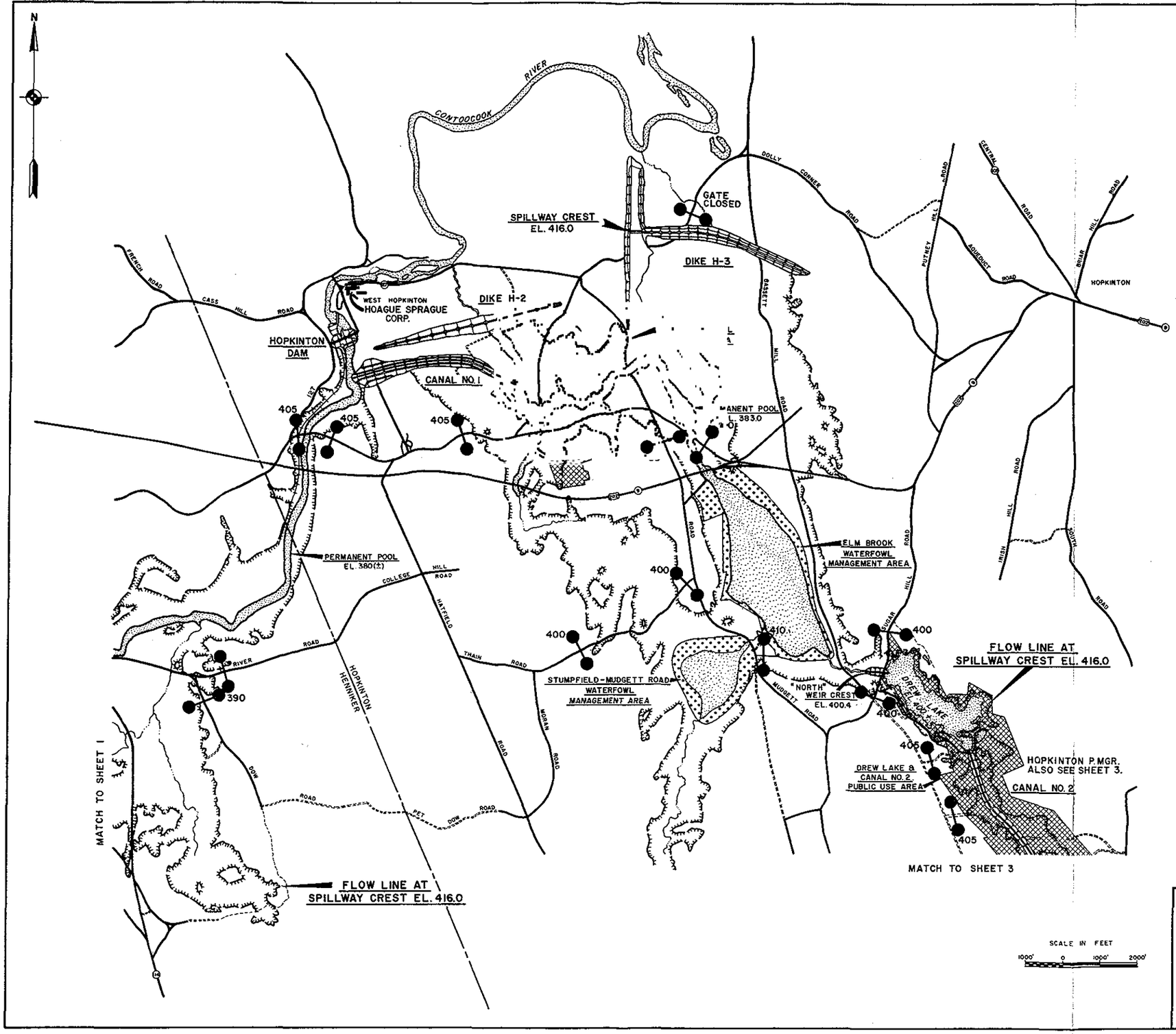

10 YEAR FREQUENCY
LOW FLOW DURATION
RESERVOIR STORAGE / INFLOW
VOLUME IN ACRE-FEET
2500
2000
1500
1000
500
0
MINIMUM RELEASE = 0
MINIMUM RELEASE = 43 CFS (0.1 CSM)
PROPOSED STORAGE - 1,790 AC-FT. ELEV. 383 FT.
TOP OF PERMANENT POOL - ELEV. 380 FT. - 700 AC-FT.
INVERT ELEV. 366 FT.
NOTE:
RESERVOIR LEVEL
AT TOP OF PERMANENT
POOL AT BEGINNING
OF STORAGE
0
10
20
30
40
50
60
70
80
90
DURATION IN DAYS
MERRIMACK RIVER BASIN
HOPKINTON LAKE
DROUGHT CONTINGENCY
STORAGE VS. FLOW DURATION

PLATE 4

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

- PUBLIC USE AREA
- RESERVE PUBLIC USE AREA
- WATERFOWL MANAGEMENT AREA
- FLOW LINE AT SPILLWAY CREST EL. 416.0
- ROAD BARRICADE

SHEET 2 OF 3 - HOPKINTON LAKE

WATER RESOURCES DEVELOPMENT PROJECT

MERRIMACK RIVER BASIN

HOPKINTON - EVERETT LAKES

RESERVOIR MAP SHOWING

ROAD BARRICADES

NEW ENGLAND DIVISION, WALTHAM, MASS.

DECEMBER, 1976

PLATE 5